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## Designing CALL for learning Chinese characters

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### Abstract

Despite the enormity of its quantity, printed or written forms of Chinese characters are composed from a limited number of common components. For example, the characters for pond(池), lake(湖), stream(江), river(河), sea(海) and ocean(洋) all contain a component in common, a three-dot component representing water. When this clue is explicitly highlighted to the students, the learning of Chinese characters can be greatly enhanced. Using computer to help students to develop this kind of structural awareness about language learning has not yet been thoroughly examined. This paper reports on the design of CALL software based on the pedagogic method to help students to develop the higher order skills to analyze and categorize Chinese characters by using components. The result of our classroom experiment has shown supportive evidence on the feasibility and the need of integrating the software with an affective and contextual way of teaching Chinese characters.

**Keywords:** Chinese characters; Courseware; Illuminative evaluation; Instruction; Multimedia; Primary; School

### Introduction

This paper reports on an initiative to enhancing children's Chinese characters learning through raising their structural awareness about the language with the support of a knowledge-based multimedia system. There is a lot of literature

highlighting the importance of structural understanding in general. In learning about a domain, a learner does not simply go through an additive process of acquiring more and more pieces of information. More importantly, the learner should develop a structured view of the domain and be able to relate pieces of information into a meaningful whole. With this structured view, the learner would be able to switch attention flexibly to focus on different parts, or at different levels of details, addressing to the issue immediate at hand, without necessarily losing sight of the whole.

Language has a complex structure. It is an amazing capability of human beings to be able to develop and use such structures. However, an emerging body of psychological research has indicated that the learners vary in their structural awareness of the language. The differences in terms of their sensitivity towards patterns of phonological, orthographic and morphological structures of the language do have important bearing on their language performance. Particularly, phonemic awareness in English was found to be predictive of the measure of the students' future reading ability (Wagner, 1987)(Ball, 1991). Students are often given the tasks of segmenting words into phonemes, connecting the phonemic segments to alphabet letters, blending the individual sounds together to pronounce the word and producing rhyming word, which are all found to be effective in raising the phonemic awareness of the students. Chinese essentially differs from English in its pictographic property. Could this open up a new dimension of investigation about graphemic awareness? Does graphemic awareness bear the same importance as phonemic awareness? How can students be helped to become aware of the structural regularity of Chinese characters?

In the area of science and mathematics, a lot of work has been done in developing technologically supported microworlds for learners to explore structural explanations behind natural and formal phenomena. However, there has been comparatively less work of this kind in the area of language learning, even less in the domain of learning Chinese characters.

Language is a system with structural regularities. Generally, these structures are learnt in a way quite different from science and mathematics. For most of the time it is being learnt while it is being used. This difference might lead to a difference in the nature of the structural understanding emphasized and a difference in the role of the technology.

There has in fact been a long on-going debate among language educators about structural awareness instruction. The opposition against such instruction can be summarized as follows: to do something and to step back reflecting about how one's doing it at the same time is difficult. Too much self-consciousness can inhibit the learner as a user of the language. In order to talk about structures, a higher-order language is needed, and that would be an additional burden for the language learner.

Without disregarding the above positions, the authors would like to argue that incidental and conscientious learning of a language need not be mutually exclusive. To think about the structure of a language while using it is possible. It can be just a matter of degree, scope and nature. It is an empirical question how the degree, scope and nature of thinking about the language varies, in the developmental course of learning, as well as in responding to the momentary demand of the situation at hand. It is precisely this knowledge that most educators need to have in designing language education experiences for their students with due respect to both the situated as well as the systematic nature of language.

It is the belief of the authors that the technology can play an important role in the development of awareness about the structure of language. With print and computer technologies, language can increasingly become an external object in itself, which is detached from the human bodies that perform the language interaction. Language put into a written form is more amendable to a reflective mode of language usage. Language in a computer knowledge base would make the structural principles of the language more accessible to exploration. This is an area which will be explored in this paper.

When in use technology also affects our ways of thinking. While it amplifies certain aspects of experience of the world, it reduces others and puts them out of focus. The use of knowledge-based systems tends to make the objective appearance of knowledge most prominent and the contexts and people that make the knowledge often recede into the background. This project kept in mind the importance of seeing the function of technology as support for teaching and learning and questioned whether the use of technology might change the nature of language learning in a counter-positive way.

The experience of language can be diverse. Language can be part of you, enabling you to relate to people and the world, when your focus of attention is not on the language but on the people and the world. Language can also be part of the world, as a target of study to which you focus your attention. It can be something so closely bound to your moment-by-moment being in the world and your interaction with people around you. But it is also an external cultural artifact, including captured live language of the past, the language patterns that have been commonly appropriated by the society, and also analytic theory or descriptions about language. It appears to the authors that there are moments of each of these in the course of language learning, and the role of the technology in language learning should be carefully examined in respect to these different ways of experiencing language. In the learning of written words with technology, there are simultaneously operations at different levels: the concrete, the spoken, the written, and the program. There may be things that the technology can or should do and things that it should not. Learning does not happen just within the square box. The functions of the technology must be considered with due respect to the other things happening during learning.

This paper reports on an attempt to use technology to enhance young children's understanding about the structural principles of Chinese characters. It first discusses how the software was designed, in relation to understanding of the structures of Chinese characters. Secondly, the authors will share some of their ideas generated from classroom experimentation about how one might integrate the different views of a language, and the different types of computer and non-computer based activities in classrooms.

### **The Structure of Chinese Characters**

Commonly used Chinese characters number several thousands. It is boring, even if not hard, for students to memorize each of them by rote. However, the number of character components, which are needed to build up the thousands of characters, has been estimated to be only a few hundreds for most purposes (張, 1982) (國, 1997). Chinese characters actually share a large amount of components in common. The components of Chinese characters are the most basic units in Chinese, comparable to the alphabet in English spelling.

Chinese characters are also interpreted as a combination of components rather than a collection of unrelated strokes. For example, the character 明 is combined by the components 日 and 月. Since the 日(sun) is the brightest thing in the day while the 月(moon) is the brightest thing in the night, the combination of them 明 clearly means “bright”. To write the character 明, a person will complete the writing of the component 日 prior to the writing of any strokes in 月. This indicates that the character 明 is regarded as two components, 日 and 月. The writing sequence of the strokes of 日 as a component of the character 明 is also identical to that of 日 as a valid character on its own. It is thus reasonable to regard components as reusable building blocks of Chinese characters.

In agreement with this, a developmental experiment (曹, 1965, 1965) has shown a significant improvement in the ability of elementary school students to master Chinese characters during the period between the first and second grade. It is believed that at this time the students have picked out the regularity among various characters and generalized an understanding of how different characters are related with each other. The ability to recognize character components is essential in the learning of Chinese characters.

Not only should students be able to recognize the components in a character, but the students should also notice the useful information carried by the components of the character. For example, the common component 女(which means girl or woman) of the characters 媽, 姊, 妹, 姨 and 婆. The meanings of the characters are all related to female: 媽(mother), 姊(elder sister), 妹(younger sister), 姨(aunt) and 婆(grandma). This kind of components which conveys meaning to the character is called the *morphological component* 形符 (or 形旁).

Similarly, *phonological components* 聲符 (or 聲旁), which are often located on the right hand side of a character, denote sound in the characters. Sharing the component 青, all of the characters 青(cing1), 清(cing1), 蜻(cing1), 請(cing2), 情(cing4), 晴(cing4) and 睛(zing1) are spoken similarly.

Actually 85% of modern Chinese characters falls in the category of *picto-phonetic composition* 形聲字 that is a combination of exactly one morphological and one phonological components. As such, many new characters can be taught in such a way that helps students to relate the characters to some other characters familiar to them probably with components in common. Moreover, components can also be used as a cue for guessing the meaning of unknown characters. Even though students may encounter unfamiliar characters in reading, the context together with a familiar component should often suffice for students to vaguely understand the meaning, thus enabling them to continue their reading without interruption. (張, 1987)

Psychological studies also support the teaching of morphological and phonological components. Children are believed to acquire a language through one of the three ways: by rote, analogy and rule (Taylor, 1990). When children can no longer

rote memorize the large amount of Chinese characters, they have to use analogy to relate similar characters for effectively building up a large vocabulary. For example, knowing the characters 伯(uncle, baak3), 拍(beat, paak3) and 怕(afraid, paa3), children can directly derive the sound of the character 帕(handkerchief, paak3). In parallel with this, a local experiment (Ho & Bryant, 1997; Ho et al., 1999) has shown Chinese children as young as six years can make phonological and semantic analogies in reading unfamiliar Chinese characters. The implication is that systematically teaching of the function of components will probably help those students with difficulty in reading Chinese because of failure to recognize the regularity of the characters on their own.

## Software Design

The basic hypothesis of the project is that, because there are many kinds of structural regularities in the composition of Chinese characters and words, the learning of Chinese characters and words would be more effective if the learners are made aware of the principles underlying their composition. Based on the above characteristics of Chinese characters, several CALL programs have been designed and developed (Lam et al., 1993; Ki et al., 1994; 現龍, 1998a, 1998b, 1999, 2000) as teaching materials for teachers to use in classrooms. They include *Rhymes*, *Interactive Exercises on Character Origin*, *Stroke Sequence*, *Character Component*, *Morphological Component* and *Chinese Character Knowledge Base*. Each of them will be described in detail in the following sections.

### 1 Rhymes 童歌字趣

Rhymes are characterized by their ease of memory. Children often enjoy singing and intoning them and the software is a compilation of 25 pieces of rhymes with graphics, (Fig. 1.) animation and the lovable voice of children.



Figure 1 the use of rhymes with attractive graphics

Students also learn Chinese characters from the rhymes (何, 1995). Each piece of rhyme includes one cluster of characters, which all possess a component in common (四, 1994). An example is shown in Fig. 2.

山青水清天氣晴，  
青蛙有對大眼睛，

Green hill, clear water and sunny sky  
Little green frog with a pair of big eyes  
Full of insect, feeling good

吃飽蚊蟲 <u>心</u> 情好，	Inviting the bees and the dragonflies to come along
<u>請</u> 來蜜蜂與 <u>蜻</u> 蜓，	Singing, dancing and playing in harmony
你們跳舞我拍和，	Croak-croak, croak-croak, croak-croak-croak
呱呱，呱呱，呱呱呱。	<u>Little Green Frog with Big Eyes</u>

### 青蛙有對大眼睛

Figure 2 Learning Chinese characters in a cluster, with a component in common

The cluster of characters emphasized is 青, 清, 晴, 睛, 蜻, 請 and 情 as shown underlined in Fig. 2. As mentioned earlier, all of these characters contain the component 青 and are spoken like each other but, with the deletion or addition of different components, the so formed characters differ in meaning. For example, adding a 日(sun) gives 晴, which means “sunny”. Replacing it with a 虫(insect), the character becomes 蜻 as in 蜻蜓(dragonfly). The meanings of the characters 清(clear) and 情(feeling) can be deduced similarly, where the components 氵 and 忄 are the derived forms of the characters 水(water) and 心(heart).

The reason to put these characters together as a cluster is to help students to recognize the difference among the characters. Since the students have picked up the vocabulary verbally in their daily lives, homophonic errors are common. Since there is almost no difference in speech, the students often mistakenly use an incorrect character that sounds alike. Hence, teachers should help the students to understand in what situations each of the characters is used. Putting the characters in a cluster enables students to compare and contrast the characters with one another.

## **2 Interactive Exercises 互動練習**

### 2.1 Character Origin 文字由來

Chinese characters are not arbitrarily assigned symbol. Early Chinese characters are mostly hieroglyphic or pictographic and many of these characters have become components of modern characters. Pictures of the ancient forms of characters can possibly help students to memorize the written form of the present day. This exercise challenges students to correctly match characters to their pictorial origins.

Animation depicting the transformation of the characters from pictures to the written form is first shown to the students. For example, in Fig. 3 a picture of the sun has changed into an earlier form ☉ of a character. However the animation will suddenly be stopped before completion. The students then have to choose one of the characters on the panel that corresponds to the picture. If the selection is correct, in this case 日(sun), the evolution will continue until the end.



Figure 3 Matching a Chinese character with its pictorial origin

In comparison with still illustrations in books, the animation attracts the students' attention to the screen and also makes the dynamic process of how the characters evolve more visually explicit and understandable.

## 2.2 Stroke Sequence 筆順

Unlike drawing pictures, the writing of Chinese characters is governed by some commonly agreed rules, for example from the left to the right. It applies not only in the way of writing a single stroke but also in the sequence of writing the components (Law et al., 1998). In the character 明, the writing of 日 precedes that of 月 as previously mentioned. The Stroke Sequence Exercise illustrates this concept of sequencing in writing.

The character to be written is first shown in gray. Clicking the correct end of the first stroke will cause the stroke to be written, in this case the upper end of the vertical stroke on the left of 日 (See Fig. 4). The writing then proceeds as 丿, ㇀, ㇀, 日, 明, 明 and 明. If the wrong end or the wrong stroke is being selected, the stroke will still be drawn but then be immediately cleared, giving feedback to the student that he has successfully clicked a stroke but unfortunately on the wrong one.

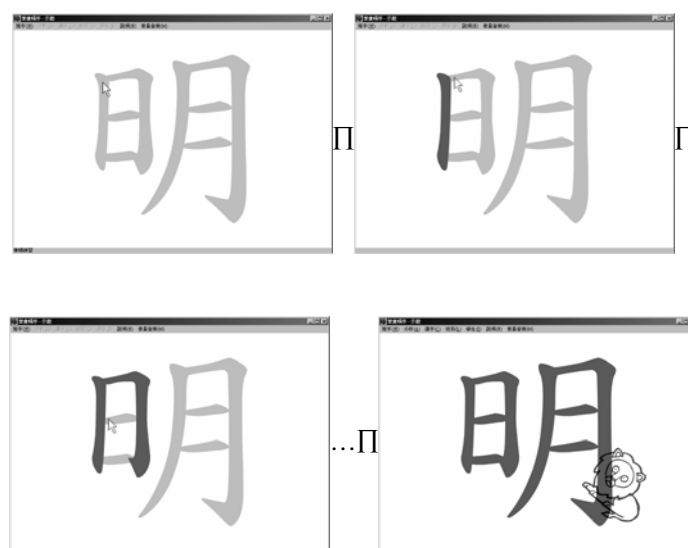


Figure 4 Writing a Chinese character with strokes in sequence

Sometimes the student may even select a stroke in the wrong component 月 instead of 日. In so doing, the component 月 on the screen will be dimmed, leaving only the component 日 remain visible. This draws the attention of the student



back to the component that he ought to finish with before proceeding (Fig. 5). In this way students are scaffolded to write the components one by one and in the right sequence.

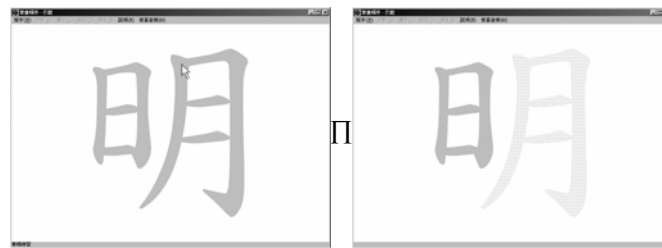


Figure 5 Writing a Chinese character with components in sequence

Upon completion, the whole character will be rewritten again so as to reinforce the correct writing order. If all strokes are selected correctly, the chop of an animal will be stamped on the character as a reward.

Note that this exercise does not train the motor skill of the students to write strokes. Being able to use the mouse to write strokes on the screen does not imply that the student can write properly with a pencil on paper. Instead the aim of the exercise is to develop the concept of stroke order rather than the practice of writing. Another thing to be stressed in the design is simplicity, which especially appeals to teachers unfamiliar with computers. Simple mouse click is used rather than such complex operation as dragging the mouse along the path of a stroke. The student is to learn the concept of stroke sequence rather than the control of mouse.

### 2.3 Character Component 部件砌字

In this exercise, students are required to recall the written form of a character when given the sound and the meaning of the character. To specify the written form, the students have to think out the components forming the character in the correct order. The purpose of the exercise is simply to remind students that Chinese characters are made up of components.

The exercise starts with the speech sound of a character (in Cantonese, which is the dialect widely used in Hong Kong), followed by a word that contains the character, “情、心情” (cing4, sam1cing4), for example. Since homophone is common in Chinese, the purpose of using the word is to state precisely which character is being referred to. With the picture of the character in mind, the students then click the components on the panel (Fig. 6), which are then combined to form the character.



Figure 6 Composing the character 情 from components

The components should be selected in the same sequence as writing the character. In the example above, the students should click the components exactly in the order of 丩 and then 青.

When the students are unable to find out the correct component, after a failure of several trials, the whole character will flash, giving a hint to the students. This indirectly guides the students towards the correct component. Without such hint, the students would be likely to give up in frustration. Until the whole character has been completed, the cat at the bottom will run across the screen and finally catch the mice. The students can then move on to the next character.

The characters to be composed can be organized into groups. In the previous example, the group of characters in question is 情, 清, 晴 and 請. These characters have been broken down into components listed in the option panel. Throughout the same group, the components on the option panel will then remain unchanged so that the students need not be overloaded by reading the components each time for a new character.

#### 2.4 Morphological Component 找尋形符

Recall that morphological component is the component that suggests meaning in a character. From the component, students can often deduce what an unknown character means, which is especially useful in reading. This exercise raises students' awareness of what kind of characters are likely to have a particular morphological component.

After hearing the sound of a character, the student has to determine which one of the morphological components the character should possess. In Fig. 7, the student is choosing the morphological component for the character 妹(younger sister) from the options of 人(human) and 女(female). If correct, 女 in this case, the bear climbs up the tree and gets the honey. Then the next character is spoken and so on.

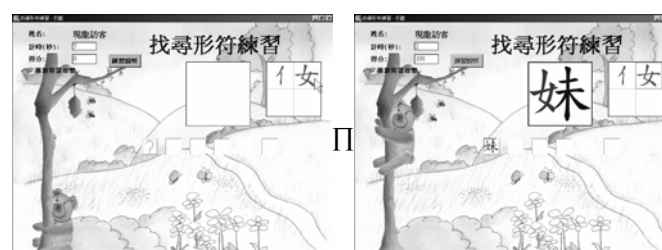


Figure 7 Identifying morphological component

The exercise ends up partitioning off the characters into two sets. One set contains 妹(younger sister), 姊(elder sister), 媽(mother) and 她(she) while the other set contains 伯(uncle), 你(you), 他(he) and 們(we or they). It becomes obvious that the characters denoting human in general possess the morphological component 人 and the characters denoting female possess the component 女. By comparing these characters, the students can easily identify the similarity in the meaning of these characters with the same morphological component.

In addition, teachers can also prepare their own exercises with the authoring tools provided. Using the tool, teachers are free to choose the combination of characters out of a total of 500 characters, tailor-made for their curriculum. (The authoring tools are also available to Character origin, Stroke sequence and Character component.) Figure 8 shows the selection of characters 妹(younger sister), 姊(elder sister), 媽(mother) and 她(she), which contain the morphological component 女(woman). When finished, an exercise with the desired characters will be automatically generated, like the one mentioned previously.



Figure 8 Generating courseware on the fly

### 3 Chinese Character Knowledge Base 漢字知識庫

The properties of five hundred Chinese characters are defined and stored in this database; including the structures 結構, stroke sequences 筆順, radicals 部首, pronunciations 讀音, liushu's 六書, morphological 形符 and phonological components 聲符 of the characters. These characters are further linked up together to form a network by their common properties. For example, with the same speech sound, homophones are connected together so that students can go from one to all of the others. Similarly for other properties, the characters are related in different dimensions. Exploring this network, students are expected to develop a mental "toolkit" from these properties of Chinese characters, which is helpful to them in learning other characters proficiently in the future.

As shown in Fig. 9, selecting 門 as a component will produce a list of characters: 門, 們, 閃, 問, 悶, 開, 聞 and 闢. All of them contain 門 as a part of the characters. The students can further specify the character to be a picto-phonetic composition. Only the five characters 們, 問, 悶, 開 and 闢 will then remain in the list. In addition to this, the students can further require the component 門 to serve as a morphological component in the characters. The list will be reduced to 開 and 闢, which are all related to 門(door) in meaning as in 開(open) and 闢(wide). The function of the component 門 can also be changed into being phonological. The list will then become 們, 問 and 悶, which are both spoken like 門(mun4) as the sounds of 們(mun4), 問(man6) and 悶(mun6) respectively..

Clicking one of the characters in the list, say 問, will bring the students to another window that details all the particulars of the character 問 (Fig. 10). In the window it is indicated that the components 口 and 門 are the morphological and phonological components respectively.



Figure 9 Selecting characters by different criteria

Clicking the component 口, the students can return to the first window with the pre-set selection of 口 as the morphological component, producing another list of characters 問(ask), 啼(cry), 喊(shout), 喝(drink) and others, most of them are actions with the mouth(口). Moving back and forth, the students can explore a list of related characters, for example, from 門 to 問 to 嗎 to 媽 to 妹 and so on so forth.



Figure 10 Exploring a list of related characters

## Classroom Experimentation

The software has been tried out on a limited scale in three primary schools (about 4 teaching sessions per school); the associated classroom teaching strategies were also investigated. Most participating teachers did not have previous experience in teaching with computers. In the experimentation, all the software and materials were given to the teachers for their use. They could choose any part they liked to try and designed their own lesson plans; this so gave an insight into the ways of thinking of the teachers. Positive feedback was received and some models of teaching have been identified (祚, 1999).

From some of the best lessons, better ideas were shown about how content and activities can be structured to bring about motivating and creative usage of the language, at the same time draw learners' attention to the structural regularities and variations in the language.

One lesson using the following poem provides an illustration. The poem reads: 山青水清天氣晴，青蛙有對大眼睛，吃飽蚊蟲心情好，請來蜜蜂與蜻蜓，你們跳舞我拍和，呱呱，呱呱，呱呱呱。(Green hill, clear water and sunny sky / Little green frog with a pair of big eyes / Full of insect, feeling good / Inviting the bees and the dragonflies to come along / Singing, dancing and playing in harmony / Croak-croak, croak-croak, croak-croak-croak) The lesson proceeded as follows.

The first part of the lesson was mostly on learning the text in its context. The teacher gave a context to the topic (asking students about whether they had seen frogs and what they knew about frogs.) Then the teacher presented the multimedia poem. The students listened and enjoyed the story. The whole poem was read aloud by a child's voice in the multimedia software, together with some animation about the story. The teacher then asked pupils to close their eyes and imagine the scene and the sound.

Then the students proceed to a more detailed reading of the text. They read the multimedia poem by themselves in a group. They used the different controls to read the poem in different ways (by episode, by sentence, etc.) so as to know more about the words and phrases used. After that the teacher asked them to tell the story and their interpretation about some of the words and phrases. In the third part of the lesson, the teacher focused on the structure of some of the Chinese characters according to a particular theme.

There were a number of possible themes the teacher can pick from the poem:

- Who are in the story? Which bi-character words correspond to the insect friends? 蜜蜂 (bee), 蜻蜓 (dragonfly):  
Both of them contain the component 虫!
- Recall the pronunciation. Can you find out which characters rhyme in the first two sentences?  
“山青水清天氣晴，小小青蛙大眼睛”. The underlined characters rhyme; All of them carry the component 青.  
Why? With this similarity detected, a variation also steps forth: What do the components 丩, 日 and 目 signify?
- What actions are there? They dance and beat. The word dance (跳舞) carries the foot component (足). The word beat (拍和) carries the hand component (扌).

The teacher did not choose them all. She just chose the amount she thought right. Along a theme she opened up a dimension of learning, inviting students to name other examples they knew along the theme, and to play games in composing characters from the relevant components.

Finally, the teacher invited the class to re-visit the poem, invent body movements to play or dance the poem at the same time as they read it. The class concluded with an enthusiastic playing and dancing of the poem.

### **Useful Orientations in the Lesson**

What makes this lesson successful? How does this pedagogy differ from the current normal practice in Hong Kong literacy education?

Most Hong Kong primary Chinese textbooks follow the “divergent approach” in character learning. Articles are written with content related to the world experience of the children. Character instruction is organized according to articles. In each lesson, children are expected to learn to recognize and reproduce all new characters and words they come across in the text. Usually the new characters and words are all listed at the end of the text for the reference. In most cases, the set of characters and words are heterogeneous in terms of their structural composition or meaning. Little is said about the systemic nature of the language structure.

The approach in the lesson also starts from meaningful text as in the “divergent approach”, but subsequently the lesson proceeds to concentrate only on certain characters and words of the text. Eventually it further focuses on a very small number of characters, but uses them as a springboard to open up a theme in the structure of Chinese characters. Eventually, the students return to enjoy the context and meaning of the whole text. This is a cycle from ‘context’ to ‘structure’ and then back to ‘context’. Language learning and language awareness development are closely tied together.

The text content is chosen in such a way that it is enjoyable in itself whilst at the same time, revealing some important structural features of the language. Subsequently when developing other text, it was found that in most cases relating a context to a particular language structure can be quite natural. For example, if it is a story about mother and child, then there will naturally be words like 愛心(love), 孝心(love to ancestor), 耐心(patient), 傷心(sad), 開心(happy), 憂心(worry), 關心(care), all sharing the same character morpheme 心(heart, attitude), and if it is a story about a war between the cat and the mouse, then there are bound to be contrasting words with positive and negative connotations.

The approach is also different from “convergent approach” advocated by some educators in Mainland China. In the “convergent approach” they use text that is full of characters that share similar morphological or phonetic components, so as to make the students learn a large numbers of characters at the same time. However, to the authors many of the texts are quite artificial and it seems that, with the support of IT, once learner notice that there are some interesting themes in the language structure, they can be encouraged to explore, and it is in fact not necessary to cram everything into the text.

This lesson also illustrates the integrative use of technology-based and non-technology based whole class reading and body activities. The latter are valuable things in the classroom, which must not be lost with the introduction of technology.

## **Conclusion**

There are many studies on fostering structural awareness of students with the use of computer. However, as far as the authors know, no work of this kind, in particular graphemic awareness in learning Chinese characters, has been done. A Chinese character is a composite of components. Components represent important information about the character. Highlighting the characteristics of the components to the students can greatly facilitate their learning of Chinese characters. Adopting this pedagogic method, a number of CALL programs for learning Chinese characters have been designed and

implemented. The Rhymes enables students to learn Chinese characters in a cluster within a context. The Interactive Exercises help students to acquire different strategies on learning Chinese characters. The Chinese Character Knowledge Base provides an explorable realm where students can proceed from one character to many related characters. With these uses of the software, students gain the skills to effectively learn other Chinese characters in the future. The classroom experiment has further reconfirmed this belief. Besides this, the importance of an affective and contextual way of teaching a language has also been devised. Singing and dancing following the plot of the rhymes was found to be as important as knowing the structural regularity of the language. Putting these together, it is hoped that student will be motivated and will start to appreciate the beauty of their language.

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